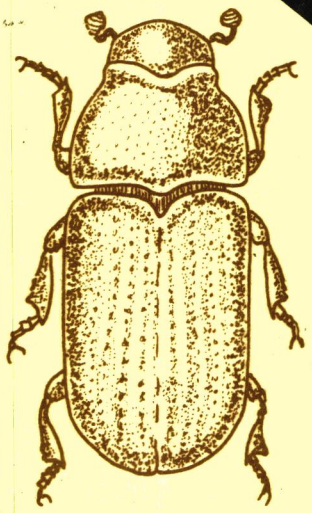
SB761
U757
#77-6

R-3 77-6

BIOLOGICAL EVALUATION
Spruce Beetle

Jemez Mountains
Santa Fe National Forest
New Mexico

1976



Southwestern Region

U. S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

5230

R-3 77-6

BIOLOGICAL EVALUATION
Spruce Beetle

Jemez Mountains
Santa Fe National Forest
New Mexico

1976

Forest Insect and Disease Management
State and Private Forestry
Southwestern Region, Forest Service, USDA
517 Gold Avenue, SW
Albuquerque, New Mexico 87102

Prepared by:

Robert E. Acciavatti

ROBERT E. ACCIAVATTI, Entomologist
Forest Insect and Disease Management

APPROVED BY:

Donald P Graham

DONALD P. GRAHAM, Director
Forest Insect and Disease Management

Thomas G. Schmeckpeper

THOMAS G. SCHMECKPEPER
Deputy Regional Forester
State and Private Forestry

INTRODUCTION

An extensive spruce beetle infestation developed in the Jemez Mountains of the Santa Fe National Forest from widespread blowdown during October 1971. The infestation occurs on the highest plateaus and mesas of the Cuba, Coyote, and Espanola Ranger Districts. The extent of the infestation was first detected during the 1975 aerial survey when trees attacked in 1974 began to fade (Appendix, Fig. 1). The infestation was again aerially surveyed on July 15, 1976, and found to have intensified during 1975 within the San Pedro Parks Wilderness, but remained static elsewhere (Appendix, Fig. 1).

Portions of the infestation were ground surveyed between September 20-30, 1976, by Forest Insect and Disease Management personnel to obtain information on the current status of the infestation. This evaluation report summarizes tree losses from the infestation, the susceptibility of the remaining green stand, and observations on the spruce beetle populations. Alternatives for managing the infestation are presented along with recommendations for action.

TECHNICAL INFORMATION

Insect.--Spruce beetle, Dendroctonus rufipennis (Kirby)

Hosts.--Engelmann spruce, Picea engelmannii Parry
Blue spruce, Picea pungens Engelm.

Type of Damage.--The spruce beetle kills trees by feeding on their phloem and thereby destroying their vascular system. The foliage of infested trees usually fades to a yellowish green the year after initial attack, but this may not occur until the second year. Some recently killed trees take on a purplish hue after needle fall due to the numerous exposed twigs in the crown.

In New Mexico, the beetle generally has a 2-year life cycle. Mature adults emerge between May and July and attack host trees soon after emergence. Egg galleries are constructed parallel to the bole and most eggs hatch by October. Small larvae feed outward into the phloem in groups and spend the first winter in this stage. As larvae mature the next spring, they construct individual feeding galleries where they form chambers and pupate during the summer. Immature adults hibernate the second winter, either in their pupal chambers or at the base of infested trees. A high percentage of these beetles may emerge, move to the root collar, and bore into an infested tree to hibernate.

Location and Extent of Infestation.--The infestation is scattered over 75,000 acres in the Jemez Mountains of north central New Mexico. About half the infestation lies within the San Pedro Parks Wilderness, Santa Fe National Forest. The spruce-fir forests are mostly virgin, with large diameter, overmature trees in dense, even-aged stands. These stands represent a highly susceptible condition for spruce beetle attack.

METHODS

Survey Areas

Ground surveys were conducted in five accessible stands where the 1976 aerial survey indicated tree mortality was heaviest. The five survey areas (Appendix, Fig. 2) were: 1 on the Cuba Ranger District; 2 and 3 on the Coyote Ranger District; and 4, 5, and 6 on the Espanola Ranger District.

Data Collection

Each area was surveyed systematically using strip plots for tallying tree losses and point sampling for green trees. Each strip plot was $\frac{1}{2}$X10 chains (0.5 acres) in size and was established by hand compass and taping with slope corrections. All beetle-attacked spruce within 16.5 feet on each side of the center line of each strip was recorded by 1-inch d.b.h. class beginning with the 5-inch class. Trees were also classed by year of attack according to the following criteria: new = completely attacked in 1976, green foliage and phloem present with eggs or small larvae in beetle egg galleries; old = completely attacked in 1975, yellow or purple-green foliage and deteriorated phloem with large larvae, pupae, or adults present, bark with emergence holes and/or hibernating adults massed at root collar; snag = completely attacked prior to 1975, no foliage present and deteriorated phloem and bark with evidence of spruce beetle galleries, but no insects present; fill-in = partially attacked in 1976 and in a previous year, but with green crowns; pitch-out = unsuccessfully attacked in 1976, pitch tubes large and abundant, egg galleries filled with resin, green crowns. Partially attacked trees (i.e., those not attacked in 1976, but strip-attacked in a previous year with or without larvae and adults, but with green crowns) were considered as live trees.

Green, live trees were tallied on variable-radius plots (20 BAF) located at the center of each strip plot. A Spiegel-Relaskop was used to measure the critical angle from each plot center. The number of trees larger than 5 inches d.b.h. on each plot was tallied by species and 1-inch d.b.h. classes. Tree measurement data on both strips and plots were analyzed by the NSEC computer program.

The relative vigor and development of spruce beetle broods within infested trees were noted in each survey area.

RESULTS AND DISCUSSION

Tree Losses

The ground survey data on tree losses in each area are presented in Appendix Tables 1 through 6. These data have been summarized below:

Survey area	Mean annual spruce mortality						% spruce attacked	% stand attacked
	1976-attacked			1975 attacked	Pre-1975 attacked	Total attacked		
	Pitch-out	Complete	Fill-in					
1 (210 acres)								
Trees/acre	4.5	0	0.3	3.1	6.1	14.0	11.7	7.0
B.A.*/acre	5.3	0	0.3	7.1	13.1	25.8	21.7	15.6
2 (70 acres)								
Trees/acre	0.1	0	0	0	1.0	1.1	0.9	0.6
B.A.*/acre	0.2	0	0	0	1.8	2.0	2.3	1.6
3 (180 acres)								
Trees/acre	0.8	0	0.1	1.1	1.6	3.6	3.8	1.5
B.A.*/acre	1.0	0	0.2	1.8	3.1	6.1	8.9	3.6
4 (75 acres)								
Trees/acre	0.5	0	0	0.8	1.3	2.6	2.0	1.3
B.A.*/acre	0.7	0	0	1.4	2.6	4.7	7.3	3.3
5 (70 acres)								
Trees/acre	2.6	0	0.6	3.3	4.4	10.9	15.7	6.2
B.A.*/acre	3.0	0	0.6	4.3	6.4	14.3	23.8	11.6
6 (135 acres)								
Trees/acre	1.7	0	0.7	0.3	3.6	6.3	5.5	2.8
B.A.*/acre	2.0	0	1.6	0.7	9.1	13.4	15.3	8.4

*Square feet

Spruce losses were greatest in survey areas 1, 5, and 6, intermediate in areas 3 and 4, and least in area 2. No trees completely attacked in 1976 were found, but fill-in and/or pitch-out attacks occurred in all areas. Pitch-outs were far more abundant than fill-ins, however. Trees with pitch-outs were considered in with tree losses because the staining fungi introduced by attacking beetles will kill trees or reduce their vigor and resistance to future spruce beetle attacks. The number of 1976-attacked trees in each area corresponded directly to the density of pre-1975 attacked trees, most of which occurred in 1974 (Acciavatti 1975). This indicates a large beetle flight took place in 1976, although most attacks were pitched out. The densities of 1975-attacked trees were highest in areas 1, 3, and 5, and lowest in areas 2, 4, and 6. Although there were fewer trees attacked in 1975 than in 1974, annual tree losses still remained above endemic levels.

Green Stand Structure

Survey data for the green stand in each area are presented in Appendix Tables 1 through 6. These data have been summarized below:

Survey area	All tree species	Spruce	Percent spruce by size class			
			Poles	Sawtimber		
			5"-11.9"	12"-15.9"	16"-19.9"	20"+
1 (210 acres)						
Trees/acre	184.7	105.9	57.9	23.2	13.2	5.7
B.A.*/acre	140.0	93.3	25.5	27.6	25.5	21.4
2 (70 acres)						
Trees/acre	179.6	118.6	73.9	11.4	9.5	5.2
B.A.*/acre	120.0	84.3	39.0	17.0	23.7	20.3
3 (180 acres)						
Trees/acre	232.2	91.0	68.7	21.1	5.8	4.4
B.A.*/acre	163.3	63.3	38.5	29.9	14.1	17.5
4 (75 acres)						
Trees/acre	201.5	127.8	84.5	8.2	7.0	0.3
B.A.*/acre	134.7	60.0	55.5	29.0	13.3	2.2
5 (70 acres)						
Trees/acre	164.0	58.3	55.2	29.9	14.9	0
B.A.*/acre	108.6	45.7	28.0	40.7	31.3	0
6 (135 acres)						
Trees/acre	222.2	108.2	72.5	15.2	7.9	4.4
B.A.*/acre	145.9	74.1	36.0	24.0	19.0	21.0

*Square feet

Schmid and Hinds (1974) determined the characteristics of stands where spruce beetle outbreaks have occurred. Two of these characteristics--abundance and density of spruce--were used to determine the susceptibility of green stands to future spruce beetle outbreaks. In susceptible stands, most of the trees per acre are spruce, and spruce basal areas are concentrated in the larger size classes. Accordingly, survey areas 1, 2, 3, and 6 have the greatest potential for continued tree losses, and survey areas 4 and 5 have the least potential.

Spruce Beetle Populations

The 1976-attacked trees were comprised entirely of fill-in and pitch-out attacks. Broods from fill-in attacks were abundant and appeared healthy in the egg and early larval instars. Hibernating adults were common at the base of 1975-attacked trees. These adults will fly in 1977 to attack trees in the adjacent stand. The largest flights will be in survey areas 1, 3, and 5, based on numbers of 1975-attacked trees.

CONCLUSIONS

During 1976, the spruce beetle in the Jemez Mountains continued to kill trees, but losses were lower than in the two previous years. Although most of the trees attacked this year were pitch-outs, there is a high probability that these trees will die from stain fungi introduced during the attacks. The remainder of the 1976-attacked trees were fill-ins. These trees should produce few beetles in 1978. In fact, brood production in partially infested trees is often negligible (Knight 1961). Additional tree mortality can be expected next year by hibernating beetles emerging from the 1975-attacked trees. The greatest potential for tree losses in 1977 exists on the Cuba District in upper Rito Cafe drainage and the Coyote District in upper Coyote Creek drainage. Highly susceptible spruce stands exist in these locales and beetle flight will be greatest there next year. Where these two factors--large emerging populations and highly susceptible stands--exist in other portions of the Jemez Mountains, the potential for continued spruce mortality remains high during the next several years.

ALTERNATIVES

The following alternatives for managing the infestation are available:

1. Individual tree treatment. Infested trees and stumps can be chemically or mechanically treated by falling, peeling, and/or burning bark. This alternative is largely ineffective at reducing tree losses, since stand conditions favoring the infestation are not changed. To

be effective, most of the infested trees would have to be located and treated for several years. The excessive cost of this treatment and high risk of missing infested trees and/or improper timing of treatment make individual tree treatment questionable. Also, this alternative does not utilize the tree resource.

2. Suppression logging. This alternative is essentially the same as alternative number 1, but the timber resource is utilized. To be effective, all currently infested trees have to be cut and removed and unmerchantable material greater than 6 inches in diameter would have to be treated as in alternative number 1. Infested stands would have to be logged on a priority basis, with the most heavily infested stands treated first. Logistically, this is difficult once an extensive infestation develops. The stand conditions responsible for the infestation are not affected by this alternative, however.

3. Sanitation logging. Under this alternative, highly susceptible green trees are cut and removed from the stand on a selective basis. The logging denies emerging beetles susceptible trees and utilizes the timber resource. Conditions favoring the infestation are altered in localized areas by changing green stand structure. Since infested trees are not treated, this approach would have little direct effect on the spruce beetle population.

4. Salvage logging. Both currently infested and dead trees would be logged selectively with this approach. The timber would be utilized, but the same limitations as in alternative number 2 would apply.

5. No action. When suppression is not justified because of economic or environmental constraints, or no practical or effective suppression technique exists, tree losses will have to be accepted.

RECOMMENDATIONS

Short-Term Action

From an entomological standpoint, there is little that can be done to suppress this infestation. The widespread nature of spruce beetle populations in highly susceptible stands makes it difficult, if not impossible, to treat trees individually with chemicals or mechanically or through logging. Inaccessible, infested trees in the San Pedro Parks Wilderness and on steep slopes limit treatment alternatives. We recommend no suppression action be taken in these areas. In those infested stands where economic and environmental constraints do not exist, we recommend a combination of sanitation and salvage logging. Unless intensive sanitation and salvage measures can be implemented, timber resource losses will have to be accepted as inevitable.

Long-Term Action

The potential for future spruce beetle infestations can be reduced by putting spruce-fir forests under management wherever possible. Initially, this involves sanitation logging to convert stands to a less susceptible condition. Thereafter, group selection and/or patch, strip, or stand clearcutting should be conducted to maintain this stand condition. Cutting practices should increase the vigor and windfirmness of residual trees. If blowdown occurs, prompt removal of infested, downed material should be given high priority.

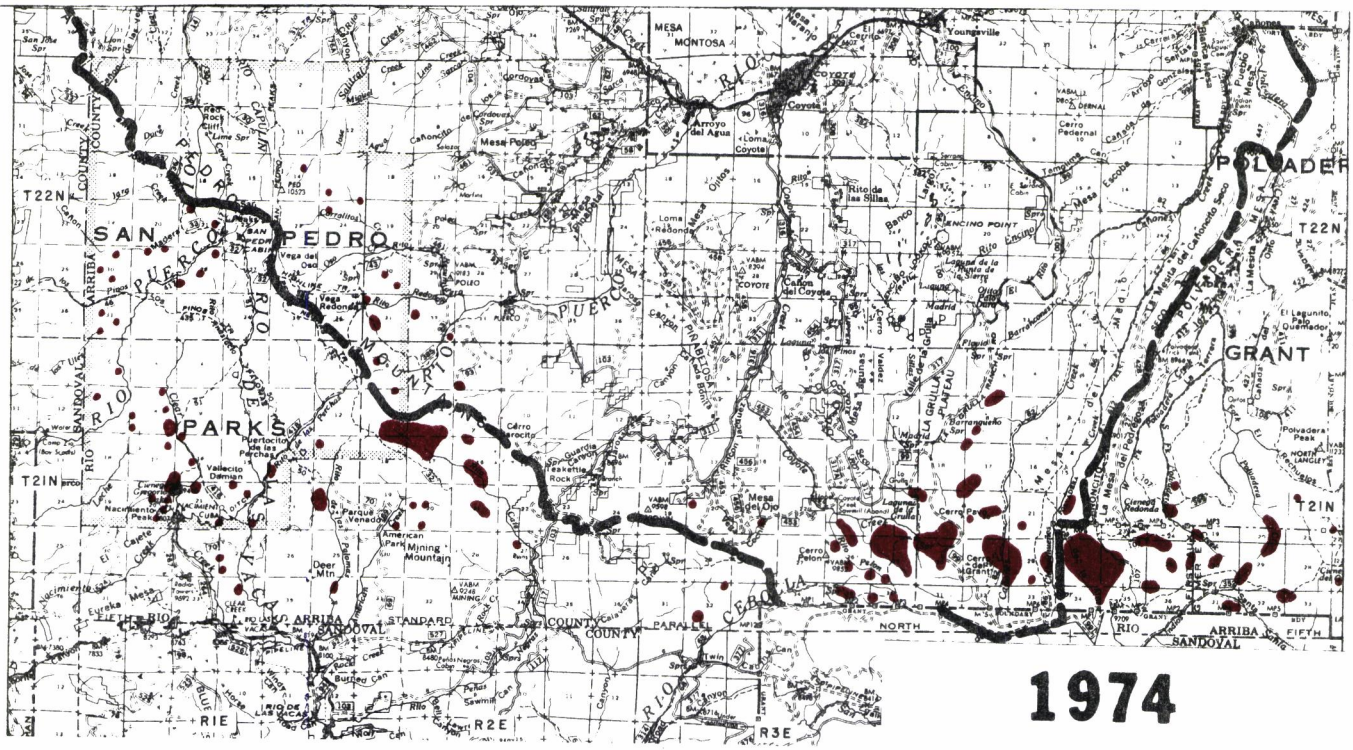
LITERATURE CITED

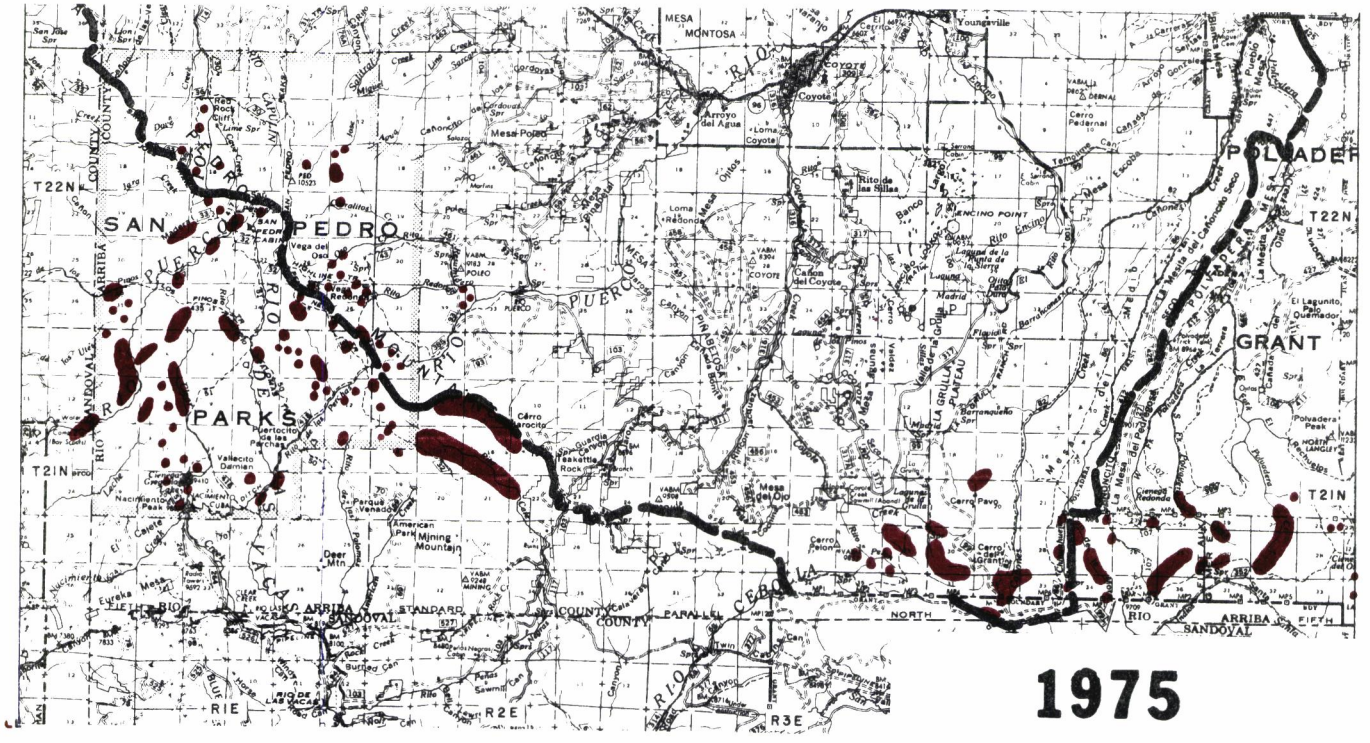
Acciavatti, R. E. 1975. Biological evaluation, spruce beetle, Jemez Mountains, Santa Fe National Forest, New Mexico. 20 pp. (Unpublished office report, R-3 76-12).

Knight, F. B. 1961. Variations in the life history of the Engelmann spruce beetle. Ann. Entomol. Soc. Amer. 54(2): 209-241.

Schmid, J. M., and T. E. Hinds. 1974. Development of spruce-fir stands following spruce beetle outbreaks. USDA Forest Serv. Res. Pap. RM-131. 16 pp.

A P P E N D I X





SANTA FE NATIONAL FOREST
NEW MEXICO
1969
Scale
1 ¼ 0 1 2 3 4 5 Miles
LEGEND
Ranger District Boundary

Infestation areas

New Mexico map location

Fig. 1.--Spruce beetle infestation, Jemez Mountains, during 1974 and 1975.

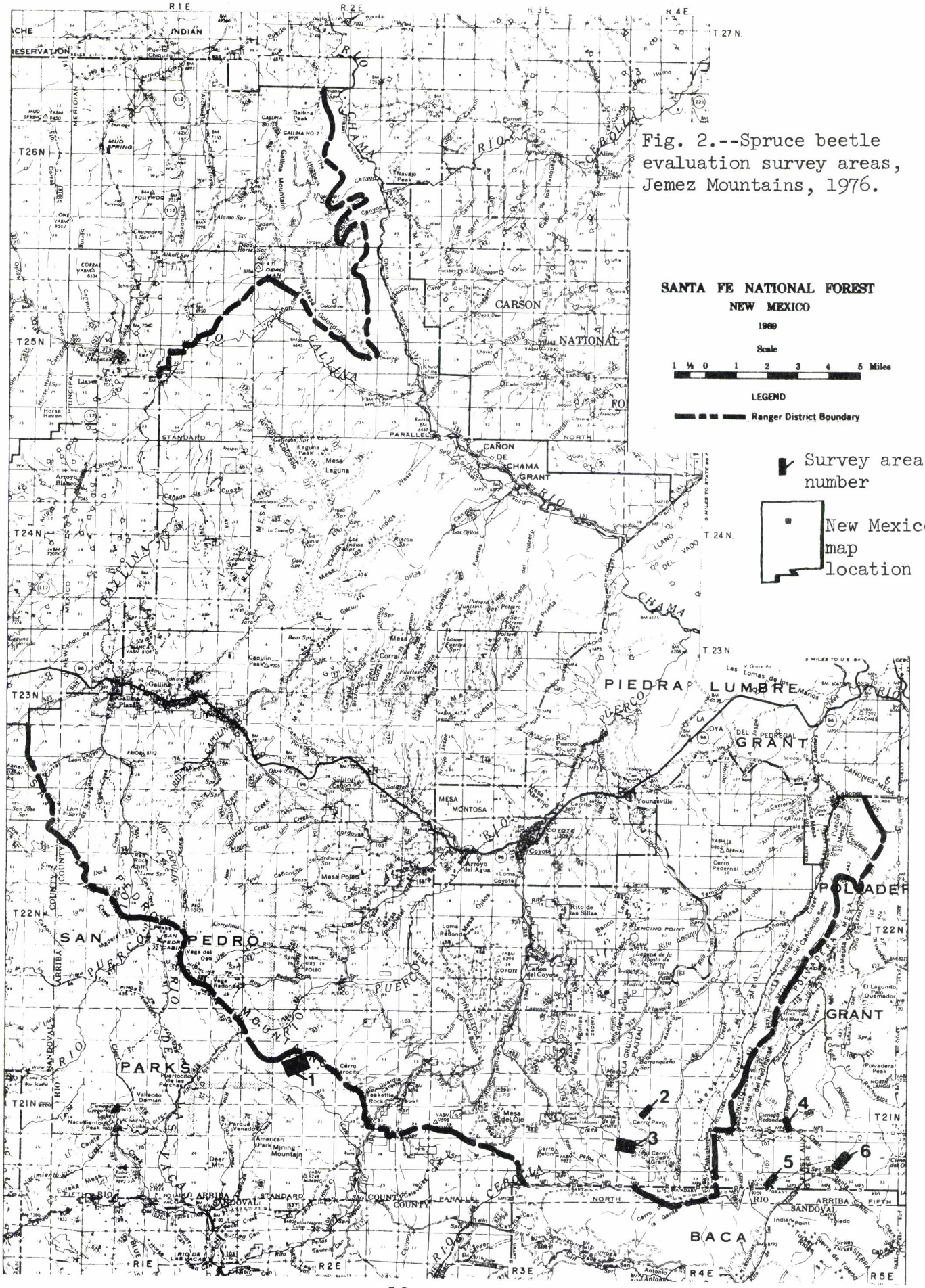


Fig. 2.--Spruce beetle evaluation survey areas, Jemez Mountains, 1976.

Table 1.--Survey area #1, Cuba Ranger District, 210 acres, 1976.

Tree class	All tree species	Spruce	Spruce by size class			
			Poles	Sawtimber		
			5"-11.9"	12"-15.9"	16"-19.9"	20"+
Live						
Number/acre	184.7	105.9	61.3	24.6	14.0	6.0
Sq. ft./acre	140.0	93.3	23.8	25.7	23.8	20.0
Beetle-attacked						
Number/acre	14.0	14.0	1.3	4.6	4.3	3.8
Sq. ft./acre	25.8	25.8	0.7	5.3	7.1	12.7
Total						
Number/acre	198,7	119.9	62.6	29.2	18.3	9.8
Sq. ft./acre	165.8	119.1	24.5	31.0	30.9	32.7

Table 2.--Survey area #2, Coyote Ranger District, 70 acres, 1976.

Tree class	All tree species	Spruce	Spruce by size class			
			Poles	Sawtimber		
			5"-11.9"	12"-15.9"	16"-19.9"	20"+
Live						
Number/acre	179.6	118.6	87.6	13.5	11.3	6.2
Sq. ft./acre	120.0	84.3	32.9	14.3	20.0	17.1
Beetle-attacked						
Number/acre	1.1	1.1	0.1	0.4	0.1	0.5
Sq. ft./acre	2.0	2.0	0.1	0.5	0.2	1.2
Total						
Number/acre	180.7	119.7	87.7	13.9	11.4	6.7
Sq. ft./acre	122.0	86.3	33.0	14.8	20.2	18.3

Table 3.--Survey area #3, Coyote Ranger District, 180 acres, 1976.

Tree class	All tree species	Spruce	Spruce by size class			
			Poles	Sawtimber		
			5"-11.9"	12"-15.9"	16"-19.9"	20"+
Live						
Number/acre	232.2	91.0	62.5	19.2	5.3	4.0
Sq. ft./acre	163.3	63.3	24.4	18.9	8.9	11.1
Beetle-attacked						
Number/acre	3.6	3.6	0.6	0.9	1.2	0.9
Sq. ft./acre	6.1	6.1	0.4	1.0	2.0	2.7
Total						
Number/acre	235.8	93.8	63.1	17.1	6.5	4.9
Sq. ft./acre	168.4	68.4	24.6	19.5	10.5	13.8

Table 4.--Survey area #4, Espanola Ranger District, 75 acres, 1976.

Tree class	All tree species	Spruce	Spruce by size class			
			Poles	Sawtimber		
			5"-11.9"	12"-15.9"	16"-19.9"	20"+
Live						
Number/acre	201.5	127.8	108.0	10.5	8.9	0.4
Sq. ft./acre	134.7	60.0	33.3	17.4	8.0	1.3
Beetle-attacked						
Number/acre	2.6	2.6	0.6	0.4	0.6	1.0
Sq. ft./acre	4.7	4.7	0.4	0.4	1.2	2.7
Total						
Number/acre	204.1	130.4	108.6	10.9	9.5	1.4
Sq. ft./acre	139.4	64.7	33.7	17.8	9.2	4.0

Table 5.--Survey area #5, Espanola Ranger District, 70 acres, 1976.

Tree class	All tree species	Spruce	Spruce by size class			
			Poles	Sawtimber		
			5"-11.9"	12"-15.9"	16"-19.9"	20"+
Live						
Number/acre	164.0	58.3	32.2	17.4	8.7	0
Sq. ft./acre	108.6	45.7	12.8	18.6	14.3	0
Beetle-attacked						
Number/acre	10.9	10.9	1.4	5.2	2.9	1.4
Sq. ft./acre	14.3	14.3	0.9	5.1	4.7	3.6
Total						
Number/acre	174.9	69.2	33.6	22.6	11.6	1.4
Sq. ft./acre	122.9	60.0	13.7	23.7	19.0	3.6

Table 6.--Survey area #6, Espanola Ranger District, 135 acres, 1976.

Tree class	All tree species	Spruce	Spruce by size class			
			Poles	Sawtimber		
			5"-11.9"	12"-15.9"	16"-19.9"	20"+
Live						
Number/acre	222.2	108.2	78.4	16.5	8.5	4.8
Sq. ft./acre	145.9	74.1	26.7	17.8	14.1	15.5
Beetle-attacked						
Number/acre	6.3	6.3	0.7	1.3	1.7	2.6
Sq. ft./acre	13.4	13.4	0.3	1.8	2.5	8.8
Total						
Number/acre	228.5	114.5	78.5	17.2	9.6	7.4
Sq. ft./acre	159.3	87.5	26.8	18.7	15.7	24.2